Apparatus for Mr Welsh's Balloon Ascents, Vauxhall Gardens, July, 1852

(See page 125)

Frontispiece

(See page 125)

M.O. 284.

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An Episode in the History of Kew Observatory.

By Sir NAPIER SHAW, F.R.S.

Mr. F. J. W. Whipple, Superintendent of Kew Observatory (Richmond), has found among the archives of the Observatory a photograph (see frontispiece), apparently a collodion positive, which is an interesting reminder of the activity of the Observatory in its early days. The photograph is dated July, 1852, and represents the paraphernalia for meteorological observations undertaken by J. Welsh, F.R.S., Superintendent of the Observatory, in the balloon ascents which were made from Vauxhall Gardens in 1852. Welsh had been appointed superintendent in that year, after two years' service in the Observatory as assistant. He succeeded Sir Francis Ronalds, who had been honorary superintendent from 1842, when the use of the building was granted by the Crown to the British Association for the establishment of a physical observatory, with the lofty idea of being in the van of progress in all such matters as the design and development of new instruments for meteorology, atmospheric electricity, terrestrial magnetism, including its relation to the sun, the variations of gravity, as well as the testing and certifying of all kinds of instruments for physical investigation.

We are somtimes inclined to think that ideas of progress in the investigation of the earth, the air and the sun are a special characteristic of the twentieth century. The following extract, from a memorandum which led to the acquisition of the Observa-

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tory in the Old Deer Park in Richmond, will deserve to be remembered, among other things, in 1942, when the celebration of the hundredth anniversary of what is " known by a misnomer of at least half a century's date as the Kew Observatory " will come due.

> " Among instruments which have been proposed, and which will probably not be constructed and brought into use without the assistance which an Institution like this alone can afford, may be mentioned : a universal meteorograph, which will accurately record half-hourly indications of various meteorological instruments, dispensing entirely with the attendance of an observer ; an apparatus for recording the direction and intensity of the wind simultaneously at various heights above the earth's surface ; an apparatus for telegraphing the indications of meteorological instruments carried up in balloons or by kites, to an observer at the earth's surface."

The balloon ascents at Vauxhall are sufficient indication that the aspirations of the memorandum were not disregarded, and perhaps the impression of vigorous activity might have been still greater if Welsh had not been the victim of tuberculosis at an early age in 1859, after testing marine barometers on voyages to Leith and the Channel Islands, setting up at the Observatory the standard barometers which are still there, Beckley's modification of Robinson's anemometer, De la Rue's heliograph, the recording magnetographs which have now been removed to Shetland, and having undertaken the magnetic survey of Scotland. "Well begun is half done," but, in the geophysical sciences, the other half is an arduous task. If to do were as easy as to know what were good to be done, Kew Observatory would have become for the average Londoner, as it is now for those who know something more than an island in the mid Surrey Golf course.

In the photograph Welsh is shown on the extreme right with headgear appropriate for ballooning. On a table in the foreground are the instruments to be used for determining the temperature and humidity of the air, provided with adequate means for securing efficient ventilation. Behind the table are members of the Kew Committee ; on the extreme left Professor W. A. Miller, of King's College, London, whose celebrated book on chemistry was a source of inspiration to many students in the second half of the nineteenth century ; next to him, J. P. Gassiot, Chairman of the Kew Committee, who provided an endowment fund for the Observatory amounting to £10,000, when it had become the Central Observatory of the newly founded Meteorological Office under the Royal Society, and the British Association had withdrawn its grant in 1871. The fund is still in the possession of the Royal Society. Next again is Sir E.

Sabine, at that time sixty-four years of age, President of the British Association and Vice-President of the Royal Society, the leading geophysical spirit of the time. Next to him again, Colonel W. H. Sykes, "one of the members of the British Association Committee, almost its first chairman." Between these notable scientific authorities and Welsh is a Beadle of the Gardens.

We have no record of the balloon ascent on the occasion of the photograph, if the date, July, 1852, is correct. We learn that two ascents were reported to the British Association in that year: the meeting was held at the beginning of September, and might, therefore, have received the reports of two of the four ascents which are described in the *Philosophical Transactions* of 1853. The dates of the four are August 17th and 26th, October 21st and

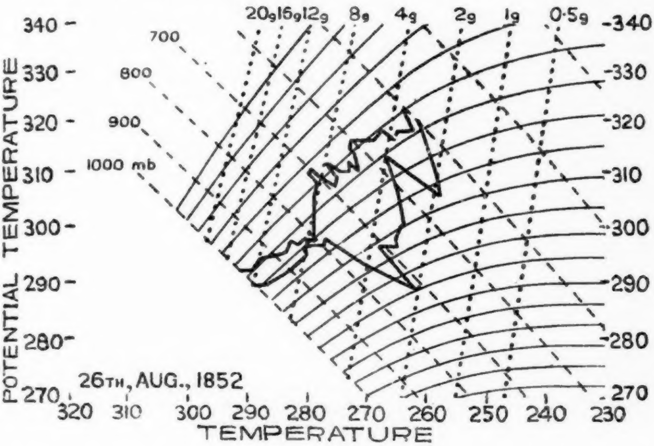


Fig. 1.

November 10th. The results are represented in engraved diagrams in the paper referred to. With the knowledge that is based upon recent experience, they must be pronounced remarkably good for records three-quarters of a century old; the provision for ventilation must have been quite efficient. The greatest height reached was 22,000 feet. On each occasion there was an inversion of lapse-rate of temperature below ten thousand feet. Welsh himself divided the graph of each ascent into two portions, nearly parallel in direction, but separated by a "discontinuity." The individual readings are very numerous and somewhat irregular, as one would expect, but the general run of the graphs is undeniable.

It is worth while to bring these results to remembrance. Two years ago I translated them into the language of the

twentieth century and deposited a lantern-slide which expressed the results with the Royal Meteorological Society. In order to show the general character of the ascents, I have set out here that of August 26th (Fig. 1) as showing the most notable changes in humidity, and that of November 10th (Fig. 2), the highest ascent of the four, on forms which have been recently prepared for exhibiting the energy of dry or saturated air in relation to the conditions of the atmosphere disclosed by soundings. The lines of reference are temperature, measured along the horizontal from right to left, and entropy (or the logarithm of potential temperature) measured along the vertical from below upward: whence it follows that area on the diagram represents thermal energy.

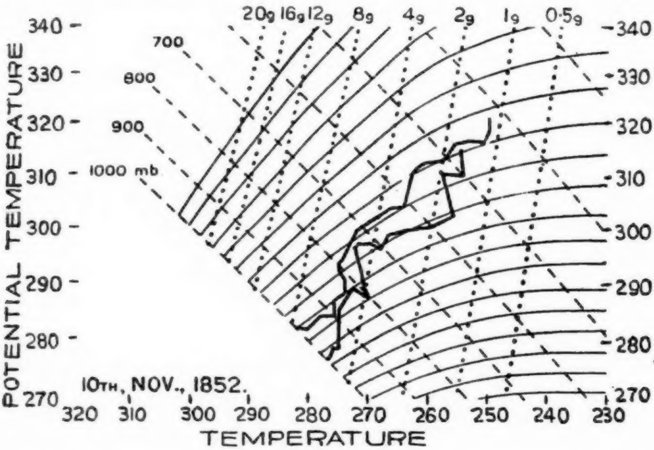


FIG. 2.

In the ground-work are lines of equal pressure, lines of equal vapour-content, and adiabatic lines, all for a saturated atmosphere. But whether the air be saturated or not, the conditions at each point of the ascent are represented with sufficient accuracy by the point on the graph which gives the appropriate temperature and potential temperature. The condition as regards humidity is indicated by marking the temperature of the dew-point arrived at by moving parallel to a line of equal pressure. The dewpoint curve, called the depegram, is dotted.* Where it coincides with the full line, the tephigram, the air is saturated; where the two curves are widely separated the air is dry.

The graph for August 26th shows two main portions of notable

*The dotting of the original has disappeared in the reproduction. The dewpoint curve (depegram) is on the right of the temperature—entropy curve in each of the figures 1 and 2.

lapse-rate, the first from 1,000 mb. to 800 mb., and the second running very irregularly from 700 mb. to 500 mb. These are separated by an "isothermal layer" in which the humidity becomes very small, the dewpoint being as much as 18° C. (32° F.) below the air-temperature though it is nearly saturated on the 800 mb. line. Above the inversion, which is complete at 700 mb., humidity, after fluctuations, is shown increased until something near saturation is reached at 500 mb. The graph for November 10th is smoother and more regular: the tephigram resolves itself into three portions with considerable lapse-rate; 1,000 mb. to 850 mb., 750 mb. to 620 mb., and 550 mb. to 440 mb. Between these are the discontinuities of isothermal layer or inversion.

Apart from the irregularities which occur in readings, either of pressure or temperature, the curves are eloquent of the state of the atmosphere. We can look back on the period of Welsh's superintendence of the Observatory as one of much activity and infinite promise.

The Problem of Atmospherics

By E. G. Bilham, B.Sc., D.I.C.

Readers of the *Meteorological Magazine* will be familiar with the important and interesting work which Mr. Watson Watt has been engaged on under the auspices of the Radio Research Board. Apart from their practical importance to the radio engineer, atmospherics—those irritating extraneous noises which often seriously interfere with our efforts to hear broadcasting from distant stations—are clearly phenomena of direct meteorological interest, since there is a manifest, though not very simple, connection between their degree of activity and the weather. Early in the history of radio communication it was recognised that atmospherics were unusually numerous and violent when thundery conditions prevailed. Subsequent investigation has shown that atmospherics are not produced exclusively in regions where lightning is actually occurring, and the phenomenon is, in short, far more complex than at first seemed probable. The Meteorological Office initiated an enquiry into the possibility of locating distant thunderstorms by observing the apparent direction of arrival of atmospherics, as long ago as 1915. Work on this and cognate problems has engaged the attention of Mr. Watson Watt continuously since that date, with very conspicuous success.

The paper* now under notice deals with a form of recorder in

* The Directional Recording of Atmospherics, by R. A. Watson Watt, *London, J. Inst. Electr. Engin.* 64 (1926), pp. 596-610.

which the direction of each disturbance affecting the apparatus is registered automatically. Briefly, the instrument consists of a large frame aerial rotated continuously about a vertical axis by clockwork. The recording drum is rotated at the same speed as the frame, and is also given a vertical movement by means of a lead-screw. A fixed pen would therefore inscribe upon it a helical trace which, when developed by spreading the paper out flat would appear as a series of parallel straight lines. The recording pen is actuated by an instrument known as the Abraham-Block oscillograph, and makes a short vertical excursion when the aerial picks up a disturbance. The record therefore takes the form of a series of parallel lines crossed by short transverse marks whose length is a rough measure of the intensity of the disturbance. On account of the directional properties of the frame aerial the response to disturbances originating in a given azimuth is a maximum when the plane of the aerial is in that azimuth, and a minimum when the aerial is at right angles. An inspection of the trace, therefore, permits of the azimuth of the main streams of atmospherics being identified. The ordinary ambiguity of 180° in the sense of the direction is present, but some determinations have been made simultaneously with an unambiguous recorder as a result of which it has been possible to discriminate, to some extent, between the two alternative directions indicated by the traces.

The records obtained in this way have been reduced in considerable detail, and the resulting data have yielded much interesting information. In the paper the results relating to the diurnal variation of intensity and direction are given in full. During the months September to February, the diurnal curve of intensity at Aldershot takes a fairly simple form, high values prevailing during the night and low values during the day, the principal minimum occurring before noon. The remaining months show the development of another maximum during the afternoon. There is a close correlation between the time of incidence of the stationary points on the curves and the times of sunrise and sunset. The principal maximum occurs six hours after sunset, and the principal minimum four hours after sunrise. The curves also indicate the existence of a small secondary maximum one hour before sunset.

It should have been mentioned that similar recorders were running during 1924 at Lerwick, Aboukir and Bangalore, as well as in the south of England. As might be expected, perhaps, the diurnal curve of direction of arrival of the principal stream of atmospherics shows considerable variation from station to station, but it is possible to draw some general conclusion which the author expresses as follows: " Early in the morning—sometimes in fact, before midnight—atmospherics arriving from the far

east, where the sun has already attained some considerable altitude, begin to show themselves. Towards 9 h. or 10 h. G.M.T. they have become the dominant stream, and arrive from a direction a few degrees south of east at the time of the autumnal equinox, and from nearly due south at the time of the winter solstice. In the equinoctial season the cum-solar swing of the hourly direction of arrival is very strongly marked, and in all cases the direction of arrival swings through south to a relatively constant south-west by west or west-south-west near midnight. This stream from the west usually remains the dominant stream until about 9 h., presumably because the American Continent produces atmospherics until late in its evening, while the Pacific is not an important atmospheric producing centre."

The location of atmospheric-producing centres by considering simultaneous records from two or more stations, is illustrated by two examples, from one of which, November 7th, 1924, a chart of isobars is reproduced. On this occasion the directions of arrival of atmospherics at Lerwick, Ditton Park, and Aboukir when plotted on a terrestrial globe intersected to indicate a source just east of Tunis. The successive hourly bearings over a period of 12 hours lay almost all along the meridian of 10° E., which coincided on the day in question with the trough of a shallow depression, in which, presumably, thunderstorms were occurring. On another occasion, records from Ditton Park and Lerwick were used to trace a thunderstorm all the way from Norway to the Black Sea. It is clear that Mr. Watson Watt has in his hands material which may be of very great value to meteorology, and we await with interest the further discussion of the data which he promises.

Official Publications

The following publications have recently been issued :—

A Short Course in Elementary Meteorology. By W. H. Pick, B.Sc. (M.O. 247).

This is the second edition of the earlier volume published in 1921, and represents a complete revision of the material, together with additional matter. For a review of the first edition, see the *Meteorological Magazine,* 57 (1922), p. 39.

PROFESSIONAL NOTES—

No. 44. *The Velocity Equivalents of the Beaufort Scale.* By G. C. Simpson, C.B.E., D.Sc., F.R.S. (M.O. 273*d*).

At their meeting in London in 1921 the International Meteorological Committee resolved " that Dr. Simpson should be asked

to look into the matter of proposing a definite scale of equivalents between the Beaufort numbers and wind velocity in miles per hour and metres per second." The results of Dr. Simpson's investigation are set out in this *Professional Note*.

The necessity for such an investigation arises from the fact that at many telegraphic stations the wind velocity is obtained from an anemometer, but is converted into a Beaufort number before being telegraphed, and in the absence of a universally accepted scale of equivalents, different services report the same anemometer readings as different forces.

The two chief determinations of the velocity equivalents to the Beaufort Scale were made by the Deutsche Seewarte in 1898 and 1916, and the London Meteorological Office in 1906. These determinations, however, show considerable discrepancies, especially in the higher numbers. Above velocities of 12 metres per second the difference is always a whole Beaufort number, and at velocities higher than 16 metres per second it is often two whole numbers, the Meteorological Office scale giving the higher velocity equivalents.

The author points out that when a sailor makes an estimate on the Beaufort Scale he bases his estimate on the waves formed on the surface of the sea, on the amount of broken water, on the sound produced as the wind blows through the rigging and on the way his ship stands up to it. None of these effects depends on the position of the observer, therefore an observer on the bridge makes the same estimate as the man at the mast-head. The case is quite different when the velocity is measured, for the velocity of the wind depends on the position where it is measured. A careful examination of the observations employed in the two determinations leads to the conclusion that the differences are entirely due to the difference in the exposures of the anemometers. The instruments used in the Meteorological Office determination had unusually free exposures, whereas those employed in the Seewarte observations were much less free, hence the British anemometers would record a higher wind velocity for a given Beaufort number than the Seewarte anemometers. The two sets of equivalents, therefore, are appropriate to different types of exposure, and they probably represent the extremes likely to be met with in practice.

The conclusion is that " there is no unique relationship between wind velocity as recorded by anemometers and estimates made on the Beaufort Scale." A telegraphic code is recommended, in which the groups of velocities are so chosen that " the group corresponding with a given code number would be between the limits of the velocity equivalents found by the Meteorological Office and the Seewarte for the Beaufort number equal to the code number." The equivalents of the code numbers are not

to be regarded as velocity equivalents of the Beaufort Scale, and in order to make allowances for the exposure of the different anemometers descriptions of the stations should be published.

Royal Meteorological Society

THE last monthly meeting of this Society for the present session was held on Wednesday, June 16th, at 49, Cromwell Road, South Kensington, Sir Gilbert T. Walker, C.S.I., F.R.S., President, in the Chair.

J. E. Clark, I. D. Margary and R. Marshall—Report on the phenological observations in the British Isles, 1925.

The phenological year December, 1924, to November, 1925, provided a striking illustration of the way in which a series of twelve months, including some extreme abnormalities, may be shown by the annual means as a normal year. December, 1924, and November, 1925, stand out as the mildest December and the coldest November for many years. The wetness of May was balanced by the drought of June. The year was exactly normal, both in temperature and in the mean date of flowering. Migrants were only a day late. The tree fruit was doubly hit. Early blooming after the warm winter exposed it to the inclemency of late April and May. Then June drought was fatal to young fruit set badly, and so also to later sown crops. Hay, early sown grain, roots, including potatoes, did pretty well where weather permitted fair harvesting, but sunshine after mid-July was lacking. Normal plant progress was uneven in various districts, the lines of equal departure from the phenological normals (" lines of equal unseasonableness ") showing that some districts were very early, others very late. The cuckoo was two days behind the swallow in south-east England, but ten days behind the swallow in Ireland ; on the other hand, in passing northward, the cuckoo made up its arrears, and reached the north of Scotland a day early. As the result of articles in *Nature* a very gratifying response has been made to an appeal for closer international phenological collaboration, especially over Europe, where twelve organizations are concerned, extending north to Scandinavia, south to Italy, and east to Russia.

S. Morris Bower.—Report on Winter Thunderstorms in the British Islands from January 1st to March 31st, 1925.

The results of the thunderstorm census show that in 1925 February was the stormiest month in England and Wales, while January was most disturbed in Scotland and Ireland. The maps of winter thunderstorm distribution for England and Wales show that the stormiest areas were mainly on or near the south coast, especially the southern parts of Sussex and Surrey

Tables and maps are given in the report, showing the dates on which storms were observed and the areas visited, together with a map of the distribution during each of the months.

Edward Kidson, O.B.E., D.Sc.—Abnormal rates of ascent of pilot balloons in the lower levels of the atmosphere at Melbourne. Observations extending from 1922-25 are discussed, and tables given showing respectively (1) rapid ascending currents in the atmosphere, and (2) low rates of ascent. These tables show that both rapid ascending currents and low rates of ascent most frequently occur in the months of September to February inclusive, that is, in the months when the land is warmer than the air and sea. The rapid ascending currents are encountered with the greatest relative frequency at 11h., and the least at 9h 30m. With the low rates of ascent the greatest and least relative frequency are at the same hours. It is suggested that the low rates of ascent are very largely the product of turbulence, the balloon being caught in the descending portions of eddy currents.

Correspondence

To the Editor, *The Meteorological Magazine*

The Green Flash

Having seen this to-night in greater perfection than ever before, it seems worth while describing the conditions.

At about 9.15 p.m. (summer time) the sky was very clear except for four or five narrow bands of stratus above the setting sun, which seemed half set behind the ridge two miles or so distant. Going up the hill caused the sun to rise above the ridge and showed it just touching a lower line of stratus. It was deep orange and decidedly bright for so low a position. Returning and facing the sun it was bright enough to be rather dazzling as one's eyes were kept on it.

As I reached the point where the stratus cloud and ridge nearly coincided, the chord visibly narrowed towards the vanishing point, became yellower for a brief instant before turning to an almost dazzling emerald green, which seemed to emit rays downwards in a semi-circle from the last fraction of the sun's disc. Not only was its brilliance greater than it has been my fortune to see it before, even at sea in the tropics, but, instead of being an instantaneous phenomenon, it lasted at least two seconds or even longer, almost as if it were disappearing behind two edges. Its duration was not quite so long as on the occasion reported to you a few years ago, when it was seen in a cleft between trees on the same ridge, but its brilliance was incomparably greater. This seems to me to have been due to the exceptionally clear night. The previous afternoon Epping

Forest, up to 14 miles distance, was visible from our office roof near Finsbury Square. The number of times we have previously seen so far in the five years we have been there is under five. The unusual visibility seems to have been widespread.

J. E. CLARK.

41, *Downscourt Road, Purley, Surrey. June 22nd*, 1926.

The Abnormal Spring of 1926

The following records taken in the screen at Ro Wen (4 miles south of Conway) show the warmth of April and the chill of May.

Mean Max. Temp. of the 7 days, April 1st to 7th	...	63·2°F.
Mean Min. Temp. ,, ,, ,, ,, ,, ,, ,, ,,	...	46·4°F.
Average of Max. and Min.	...	54·8°F.
Mean Max. Temp. of the 7 days, May 11th to 17th	...	52·7°F.
Mean Min. Temp. ,, ,, ,, ,, ,, ,, ,, ,,	...	38·7°F.
Average of Max. and Min.	...	45·7°F.
Mean Temp. of the whole of April	...	49·8°F.
,, ,, ,, ,, ,, ,, May	...	49·6°F.

The severe frost of May 16th, when the screen temperature fell to 28·8° F., caused great damage to potatoes, apples, pears, gooseberries, &c., and destroyed the young fronds of ferns and the leaves of oak, ivy, brambles and other plants.

A. WILSON.

Tiry-Coed, Ro Wen, Near Conway. June 5th, 1926.

		April.	May.
[Mean Temperature at Rhyl is	..	46·2	51·2
,, ,, ,, Llandudno is	..	46·8	51·8

Ed. *M.M.*]

The Cold Nights at Garforth

Miss Geake† has most unfortunately failed to observe a striking south-country parallel to Garforth in the matter of cold nights with respect to surrounding stations, viz., Wokingham, with a mean annual minimum of 38·4, or only +0·3 above that of Garforth.*

A couple of years or so ago, I made enquiries about this station at the Meteorological Office, but in consequence of its cessation, a really satisfactory solution could got be obtained. I suspected, however, that the cold nights at Wokingham were due partly to the fact that this town is in the heart of the sandy pine and heath country along the borders of Berks, Surrey and Hants, and also partly, perhaps, to the situation of the observing station in a hollow. To try and test these assumptions I made a special visit to Wokingham, and found that the town itself is in the midst of green pasture-land for the most part undulating

* *See Book of Normals*, Section I., p. 15.

† *See Meteorological Magazine* 61 (1926), p. 77.

with some deep wooded hollows. I had no idea where the former station was, and so could not proceed any further with the matter.

I think it is very likely, however, that radiation-cold, favoured by the abundance of semi-naked sand around Wokingham, would lower the minima near the town itself, even though the immediate surroundings are more fertile, whilst the deep hollows in question would provide for the other possibility which I mention. It is well known that, of all soils sand is the most favourable to extremes of temperature, and the maxima at Wokingham are quite high, comparatively.

The case of Wokingham is far more outstanding than that of Salisbury, to which Miss Geake refers, and if you can investigate the case more closely, I should be very glad. These local peculiarities never appear on generalized isothermal charts as determined by major geographical factors, but their existence should always be borne in mind.

L. C. W. BONACINA.

27, Tanza Road, London, N.W. 3. June 12th, 1926.

[The report of the inspector who visited the station at Wokingham in 1910 contains the following remark: "The low temperatures sometimes recorded at this station are probably right, as the idiosyncrasies of the minimum thermometers are clearly recognised and guarded against." The station was on Bagshot sands (the same formation as that which constitutes Hampstead Heath). It apparently lay on the southern slope of a coombe which opens to the westward and has a steep slope up to high ground, exceeding 300 ft., to the eastward. This exposure offers the possibility of accounting for the low minimum temperatures by the accumulation of cold air drainage in a hollow, but our correspondent's explanation of the cooling due to radiation from "semi-naked" sand is not excluded.—Ed. *M.M.*]

NOTES AND QUERIES

Comfort

One of the reproaches most frequently levelled against meteorologists is concerned with their treatment of statistics, especially in the domain of climatology. The climatological table in its standard form, with its columns of mean and extreme temperature, mean humidity, rainfall, days of weather, and wind direction gives a large amount of useful information in a small space, but it is stated—and with some truth—that it does not give a real picture of the "climate" of a place. The late J. von Hann was fully alive to this and he supplemented his statistical matter wherever possible with word-pictures of the weather quoted from residents of the regions described, but this is not a complete

solution. One can at least compare the statistics from one place with those from another place and say that " A " is sunnier than " B " but has more north winds, but descriptions cannot be compared directly. What we require is some numerical index which will express the general climate of a place as a single figure on a scale, and various attempts at such a scale have been made from time to time. One of the difficulties is, of course, that different people look at climate from different points of view. The doctor regards the health value, either as a whole or from the point of view of various maladies, and he considers the needs of the individual. At the other extreme we have students of geographical history, such as Ellsworth Huntington, seeking for general causes and finding them in the different effects of various climates on the physical and mental energy of whole races of men and drawing charts of the distribution of " climatic energy " over the globe based on a simple formula. But the ordinary man, who is not ill and not addicted to self-analysis, requires something different, which may be termed the " comfort value " of a climate. " Comfort value," however, is hard to define and harder still to assess, as is shown by a symposium of " Papers on the Relation of the Atmosphere to Human Comfort," which was published in the *Monthly Weather Review* of the U.S. Weather Bureau for October, 1925.* Two quite different lines of attack are developed ; the first, in papers by C. F. Brooks and E. C. Donnelly, regards the cooling power of the climate as the main consideration, and the second, in papers by G. F. Howe, E. S. Nichols and J. Elmer Switzer, seeks a solution in the narrower definition of daily weather types.

In some early work on the subject, the human body was regarded as cooling by evaporation like a wet-bulb thermometer, and the readings of the latter instrument were employed as a test of the fitness of a climate for occupation by white men. Thus Griffith Taylor employed a " climagraph," in which the wet-bulb temperature for each month was plotted as the ordinate and the relative humidity as the abscissa. The effect is more complicated than this, however. Dr. Brooks describes the rate of cooling as a complex of the air temperature, wind velocity, rate of evaporation, intensity of radiation and clothing. The first two factors have been well studied by Dr. Leonard Hill with his katathermometer, but the others are largely unknown. Brooks gives a complicated formula representing the effects of temperature and wind, and Donnelly adds rather arbitrary terms for the evaporation and radiation, but the application of the latter's formula to the daily weather records at Los Angeles appears to give excellent results. The curves show that for most of the year

*Washington D.C., U.S.A. Dept. Agric. *M. W. Rev.* 53 (1925), pp. 423-437.

the cooling power "is just a little more than sufficient to compensate for the heat evolved by metabolism (of a man seated in the shade), thereby insuring comfort." The increased cooling power due to the evaporation of sweat would suffice to keep comfortable a tailor or shoemaker, but not a man sawing wood in the shade. A man in the sun, even if he be idle, would be uncomfortable during most of the year. These examples show very clearly the practical value of the formula, when it has been confirmed or improved by experience and further research.

The second line of attack has not yet got so far. The idea is to classify each day as one of a number of types, such as hot and rainy, or cool, fair and windy, according to its temperature, humidity, wind velocity and sunshine, but the number of proposed types varies enormously, G. F. Howe having 13 and E. S. Nichols as many as 720. The results can be expressed in tabular form, the more readily the fewer the types, and the tables provide ready answers to many questions about which the standard climatological table is blank, such as "Are the cold days always dry ?" while the frequency of different types of weather can be charted to show variations from place to place. The next step would be to assign comfort values to the various weather types, but this is very difficult ; in fact Donnelly tried to do so and abandoned the method in favour of direct calculation from a formula. Hence it seems that the further development of this interesting practical application of climatology is most likely to result from the statistical investigation of further experimental data. It may be found necessary to bring in other elements, such as atmospheric pollution, thunderstorm activity, the day-to-day variation, and even such elusive variables as the "comfort value" of different out-looks under various meteorological conditions. The final formula for the "comfort value" of a climate may present a fearsome appearance, but this will not detract from its value provided that the idea for which it stands is clearly understood.

An Early Meteorologist*

At the present time when French dynamical meteorology is advancing along new lines owing to the development of aeronautics, the Office National Météorologique de France has thought it right to bring before her modern meteorologists the important contributions made to their work by the French *savants*. A series of extracts from their memoirs dealing especially with meteorology and its relationship with aeronautics is to be published, of which those of Lavoisier (just issued) forms the first number. Other *savants* to whom French meteorologists are

* *Extraits des mémoires de Lavoisier concernant la météorologie et l'aéronautique.* L'Office National Météorologique de France, Paris 1926.

much indebted, whose memoirs are to be published are: Le Verrier, de Tastes, Teisserenc de Bort, Durand-Gréville. Lavoisier's memoirs, which are written in a very clear and easy manner, are not confined to one or two aspects of meteorology; they range from observations of the Aurora Borealis and reports on the construction of instruments, to theories on the formation and constitution of the atmosphere and rules for forecasting weather changes. In the last mentioned essay, written in 1790, he gives eight main rules for forecasting with the help of the barometer. After discussing the general movements of the air he adds that, with the help also of observations of the humidity of the air and the force and direction of winds at different heights, forecasts for one or two days in advance could almost always be made and that it would be possible to publish every day a forecast of much use to the general public. Three of his longest essays are devoted to a study of extreme cold experienced in the winter of 1776.

Rankin's Halo observed on May 16th

We have received from Mr. C. J. P. Cave a photograph of the double halo which was seen over a wide area of south-east England on May 16th. According to the particulars given in Mr. Cave's letter to *Nature* (June 5th, 1926, p. 791), the radius of the inner halo was $17\frac{1}{2}°$ to the inner edge and 21° to the outer edge; it is evidently Rankin's Halo, which is excessively rare, and has never been photographed before. It was hoped that it would be possible to reproduce this unique photograph in the *Meteorological Magazine*, but, unfortunately, it would not stand reproduction. It has been included in the Meteorological Office Album of photographs.

Some measurements were also made by Mr. F. Addey, at Lee, Kent, who found the radius of the inner halo to be 18° to the inner edge, and 21° to the middle of the dark band separating the two halos. He noted that the inner edge of each halo was red and the remainder colourless, and that they were not visible below the level of the sun.

This double halo was referred to on page 111 of the *Meteorological Magazine* for June, in which the date was inadvertently given as April 16th.

The Uppermost Regions of the Earth's Atmosphere

The 1926 Halley lecture, which was delivered at Oxford on May 5th by Dr. G. M. B. Dobson, constituted a brief survey of present day knowledge of the atmosphere at extreme altitudes. Our knowledge comes from a variety of sources. Observations

of the aurora and of meteors occurring in these regions are used to give some indication of the actual state of the atmosphere at these heights. The aurora is most frequent at a height of about 100 km. (60 miles), and is considered to be due to an electrical discharge produced by ionisation of the atmosphere by charged particles shot from the sun. The spectrum of the aurora is a line spectrum which includes the lines of nitrogen, argon, neon, but the most intense line observed, of wave length 5,578 A° (green) cannot be attributed to any element. It is possibly due to a mixture of hydrogen and helium. No hydrogen lines have been observed in the aurora spectrum.

Observations of meteors have been used to calculate the temperature and density of these upper layers. Calculations tend to show that from 10 to 55 km. in temperate latitudes, the temperature continues at about 220° a, (—63° F.) but above 60 km. the air appears to be much warmer, and comparable with that at the earth's surface. This increased temperature is attributed to the formation of ozone by the action of the sun's ultraviolet radiation on oxygen. Ozone absorbs ultraviolet radiation strongly, but visible radiation only slightly, so that the higher layers containing oxygen will be warmed considerably. This increase of temperature above 60 km. may possibly be responsible for the bending downwards of sound waves which have reached these heights, and thus cause the "silent zones" associated with the propagation of sound waves from explosions.

Harmonies of Tone and Colour in Scenery

In the *Geographical Journal* for June, 1926, there appears from the pen of Dr. Vaughan Cornish an extremely interesting paper on "Harmonies of tone and colour in scenery determined by light and atmosphere." The paper is the result of an attempt, during a period of six years, to provide a scientific foundation for the æsthetic study of scenery. Examples are drawn from various parts of the world. The author considers that the scientific result exceeded his most sanguine hopes; appearances which it was thought could only be described, can also be explained, and impressions supposed to be merely due to intellectual association, which is personal, can in many cases be traced to a more permanent and general origin in the habits and sensations of the eye. The paper is divided into five sections: 1. the relief of the land; 2. vegetation; 3. hoar frost and snow, with remarks on wind-blown sand; 4. water; 5. fog, aurora, cloud and clear sky.

Much of the material in the first section treats of the Swiss Alps, their changes in tone and colour under varying atmospheric effects, and at different hours of the day. Three varieties of

atmospheric conditions are considered when treating of English plain scenery: the fine day with the air of polar origin; the misty day; and the anticyclonic type of fine summer weather.

Dealing with vegetation, the plane, birch, pine and palm trees are of singular merit from the author's point of view. The transparent lattice effects of the bare boughs of the plane tree in a foreground are noted as increasing the apparent magnitude of a background of buildings, the action being partly a stereoscopic one, and partly a tone contrast. Against the saffron or orange band of a fine-weather sunset the tracery of the bare birch gives one of the most charming effects of our open English winter. For a bolder silhouette of the evening sky, the pine is pre-eminent, at any rate, in northern latitudes, but there is no tree to equal the palm in the boldness of its silhouette, the most distinctive feature of sunset in the Tropics. The change of vegetation with change of season in the south of England is dealt with at some length.

Dr. Vaughan Cornish considers that the full beauty of hoar frost is admirably displayed by the climate of southern England, and we again find commendation of the birch and pine, the former under hoar frost conditions, and the latter under snowfall. A large measure of attention is directed to the variations in tone and colour to be found in the Swiss Alps in association with snow. Only at sunrise can desert scenery be said to be attractive, one of the cases in which the beauty of a landscape is not dependent upon an atmospheric veil, but upon the unveiling effect of clear air.

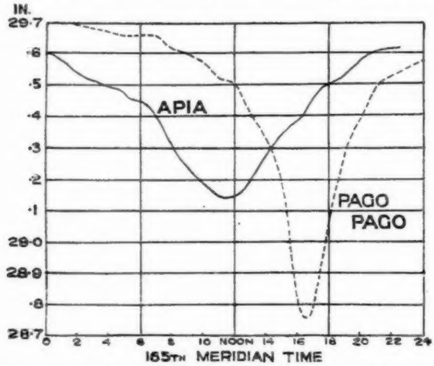
The enhancement of a scenic view when reflected in a lake is attributed to the fact that the whole of the reflection has the effect of being in one pictorial plane. No account is taken, here, of the possible effect of the light being polarized under such conditions. The rarity of the reflection of the sunset colours on the ocean is remarked upon. The sky is best mirrored when there is no ripple, and when there is sufficient sediment in suspense to make reflection mainly superficial. This effect is also to be noticed in certain rivers: personal experience brings to mind the contrast between the Thames and the Shannon, the former frequently reflects the sunset colours perfectly, the latter seldom.

Dr. Vaughan Cornish maintains that to appreciate the colours of an unclouded sunrise or sunset it is necessary to assume a recumbent attitude. The colour bands then appear longer, narrower, and more distinct, and new transitional tints are also revealed. This mode of viewing not only enables the effects of refraction to be seen in greater detail, but discloses more clearly the layered structure of the air.

S.C.R.

Tropical Cyclones

Two disastrous tropical cyclones visited Central Polynesia during the first week of the year 1926. On December 31st a cyclone developed north of the Samoan Islands (14° S. 172° W.) and travelled through the Group in a southeasterly direction,



the centre moving at a rate of about 10 miles per hour. The lowest barometer reading at Apia Observatory was 29·14 in. (986·8 mb.), but at Pago Pago (Tutuila), 70 miles east-southeast from Apia, during the calm at the centre of the storm, it fell to 28·75 in. (973·6 mb.). The maximum wind velocity at the latter place was estimated at 80 miles per hour. The rainfall for the 36-hour period about the storm centre was 7·5 in. at Apia and 15·1 in. at Pago Pago. Three natives were killed and Government property was damaged to the extent of £10,000.

On January 2nd and 3rd another cyclone occurred in the Society Group, 1,500 miles east of Samoa, devastating four islands and causing eleven deaths.

ANDREW THOMSON.

Thunderstorms at Aguilas

The following summary of his study of the thunderstorms which have occurred at Aguilas, Murcia, Spain, during the last seventeen years (1909-1925) has been contributed by Mr. G. L. Boag.

TABLE I.—MONTHLY FREQUENCY OF THUNDERSTORMS.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Total (17 yrs.)	3	1	3	4	14	7	4	4	18	13	5	2	78
Mean ...	0·2	0·1	0·2	0·2	0·8	0·4	0·2	0·2	1·1	0.8	0·3	0·1	4.6
Percentage on year ...	4	1	4	5	18	9	5	5	23	17	6	3	100
Number with rain	3	1	3	3	10	3	3	2	16	13	5	2	64

It will be noticed that at Aguilas there are two yearly maxima

of thunderstorms, the chief maximum in September and a secondary maximum in May. Of the years under consideration, 1914 and 1925 were those during which the most thunderstorms occurred, 9 in each, while in 1920 there were 8. The data are also tabulated according to the time of day at which they occurred (Table II.). In summer there is a well-marked maximum frequency in the late afternoon (16h–18h.), due to convectional thunderstorms. In winter the diurnal variation is less marked, the convectional maximum in the late afternoon persists, but there are also indications of a second maximum near midnight.

TABLE II.—HOURLY VARIATION IN RELATION TO MONTHS.

	1h-3h	4h-6h	7h-9h	10-12-h	13h-15h	16-18h	19-21h	22-24h	Total
Summer ...	3	3	1	8	5	17	7	7	51
Winter ...	3	2	0	3	3	9	2	5	27

Usually the thunderstorms were accompanied by slight rainfall, less than half an inch, but on fourteen occasions there was no rain at all, and on nine, more than an inch, the heavier rain occurring, with two exceptions, during the winter storms. Only on two occasions was the rainfall greater than two inches. On October 22nd, 1918, 2·47 in. was measured, and on October 30th, 1923, 3·83 in. Both these thunderstorms occurred at 17h. It is stated that "these storms invariably come drifting rapidly from the south-west direction and to seaward of mountain ranges running parallel to the coast." The record is of thunderstorms actually occurring, and does not include distant thunder.

Low Humidities in Northern Provinces of Nigeria

In summarising the meteorological returns received regularly from stations in the Northern Provinces of Nigeria, some very low humidities are found from time to time. The apparent dryness is rendered more remarkable by the fact that the hour of observation is 9h., and therefore not in the hottest part of the day. A selection of these low humidities recorded during the year 1925, and the early part of 1926, is given in the table, from which it will be seen that at Sokoto on March 1st, 1925, the difference between the dry and wet bulb readings was as much as 36° F. The relative humidities have been calculated from the *Tables for the Reduction of Meteorological Observations in India*, and on two occasions the calculated figures are as low as 2 per cent. It may perhaps be doubted if the formula which was employed in preparing the humidity tables is accurate for such very great differences between dry and wet bulb readings, but the fact that there are six values of two or three per cent.

and yet not a single observation which would give a negative relative humidity tends rather to support the accuracy both of the readings and of the humidity tables.

The stations at which these low humidities occur are in the north and east of the country, where the climate is semi-arid.

Date	Station	9 h. temperature		Relative Humidity	Max. Temp.	Wind	
		Dry Bulb	Wet Bulb			Direction	Force
		° F.	° F.	%	° F.		
1925, Feb. 11th	Kaduna Capital	74	49	5	88	NE	2
1925, Feb. 18th	Sokoto..	80	52	3	93	NE	6
1925, Mar. 1st ..	Sokoto..	95	59	2	104	NE	5
1926, Feb. 3rd ..	Kaduna Capital	74	48	2	86	E	2
1926, Feb. 7th ..	Yola ..	78	51	3	98	SE	2
1926, Feb. 22nd	Yola ..	80	52	3	100	SE	5
1926, Feb. 26th	Hadeija	83	53	3	95	E	2

The average annual rainfall is 25 inches at Sokoto and 39 inches at Yola, but it falls entirely between the middle of March and the end of October. The "winter" months are quite rainless, the sky is almost free from clouds, and the winds blow continuously from north-east, east or occasionally south-east, that is, out of the dry interior of Africa, and mainly from the Sahara. The north-east wind is the well-known dust-laden "Harmattan" which is analogous to the "Khamsin" of Egypt. Hence the air is very dry throughout the "winter," and when the country begins to warm up in February owing to the increasing altitude of the sun, the dryness becomes accentuated. The average relative humidity at Sokoto is as low as 26 per cent. in February and 28 per cent. in March, after which it increases rapidly to a maximum of 74 per cent. in August.

Reviews

Hygrometertafeln. Tafeln zur Bestimmung des Wasserdampfgehaltes der Luft, by Dr. J. N. Dörr, and Anleitung zur Behandlung eines Haarhygrometers und zur Verwertung für die lokale Wettervorhersage, by Dr. A. Schlein. Size 10×7, pp. 32, Vienna, 1925.

The last issue of hygrometric tables by the Austrian Central Institute for Meteorology and Geodynamics was the sixth edition of Jelinek's psychrometer tables, in which was included a set of tables by Pernter for the determination of vapour pressure from the indications of a dry bulb thermometer and a hair hygrometer. That issue, which was dated 1911, is now out of

print, and the present work is published as the official hygrometric tables for use at the meteorological stations of the Central Institute, and for other purposes. The work contains no psychrometer tables, or tables for the reduction of dry and wet bulb readings ; but it is assumed that humidity determinations will be made by means of the hair hygrometer. It is however understood that a new edition of tables for the determination of humidity from readings of the dry and wet bulbs is in preparation, so that it appears that both methods of humidity determination are officially recognised in Austria for use at climatological stations.

In the introduction to the tables the disadvantages of the psychrometer are referred to under three headings : (1) the unreliability of the wet bulb at temperatures below the freezing point ; (2) the disturbing effect of wind ; and (3) the effect of change of pressure, which is considerable in the case of high level stations. A remark made in 1783 by de Saussure is quoted : " After all other possible hygrometers have been tried, we shall always come back again to the hair hygrometer."

The advantages claimed for the hair hygrometer are that it remains unaffected by change of pressure, wind velocity and temperature. The well-known disadvantages of the instrument are described, and instructions for adjusting Lambrecht's polymeter, which is apparently the type of hygrometer in general use at the Austrian stations, are given in some detail.

The main table has two arguments :

(1) Values of relative humidity from 5 per cent. to 100 per cent., in steps of 5 per cent. ; and (2) values of dry bulb temperature from $-35°$ C. ($-31°$ F.) to $+50°$ C. ($122°$ F.) in steps of whole degrees, half-degrees, fifths or tenths, according to the temperature.

The values for these two arguments are obtained by direct observation from the hair hygrometer and the dry bulb respectively. The body of the table is entered with the corresponding values of vapour pressure, expressed in millimetres of mercury. For the benefit of those who require vapour pressure to be expressed in millibars, a subsidiary conversion table is given. The values of saturation vapour pressure which have been used are those published by the Reichsanstalt in 1919. They extend from $+50°$ C. ($122°$ F.) to $-16°$ C. ($3°$ F.), but a further extension to $-35°$ C. ($-31°$ F.) was specially made for use in this publication by Dr. K. Scheel of Berlin. The vapour pressures at temperatures below the freezing point are, as is customary, those appropriate to a water, not an ice surface.

The tables are convenient in form, and are excellently printed on paper of good quality.

There are many who will wish to follow with interest the

outcome of the decision to accept humidity determinations by hair hygrometer from ordinary meteorological stations. While wishing the venture all success, we hope that, in due course, a report on the matter will be published for the benefit of other meteorological services.

R.C.

Het Klimaat Van Nederlandsch-Indie. Sumatra. By C. Braak K. Magn. Meteor. Obs., Batavia, Verh. No. 8, Vol. II., Part 1. Size $11 \times 7\frac{1}{2}$, pp. v. +156 (Dutch) + 67 (English Summary). *Illus.* Batavia. 1925.

The first volume of *The Climate of the Netherlands Indies*, various parts of which have been reviewed from time to time in the *Meteorological Magazine*, forms a model of the general treatment of the climatology of an extensive area. According to the plan of the work, the second volume is to contain a detailed account of the local climatology, and the first part of this volume, dealing with the climate of Sumatra, which has now appeared, maintains the high standard which the author has set himself. The East Indies have a large output of agricultural produce, and climatological studies of this nature have a great economic value in guiding the cultivation of the land to the best advantage, but in addition there is abundant material which will be of service in studying the more purely scientific problems of the tropics, though, in these days of the study of world weather, no man can say where practical meteorology ends and academic meteorology begins. It may be remarked that this book would have been of great value a year ago, when the chances of the various sites in Sumatra for successful observation of the total eclipse of January 14th, 1926, were under consideration.

The variation of the different climatological elements is mainly related to the winds, which themselves present an interesting study. Sumatra is a long rather narrow island extending in a north-west—south-east direction, a mountain ridge near the western coast forming a backbone. This ridge interrupts the general flow of the monsoon winds, and at low levels the only important air movement is that due to the land and sea breezes or, in the interior, the mountain and valley winds. From May to September there is a powerful westerly air current between the levels of about 1,000 and 5,000 metres, while at greater heights there is a strong easterly current. Many of the mountain summits project into this westerly current. During these months pressure at sea level is generally higher to the west of the ridge than to the east, and at times the difference becomes accentuated, usually owing to a fall of the barometer on the eastern side. At these times the westerly current is apt to descend from 1,000 metres to the surface of the ground; on the western side this

results in an increased rainfall, but in the east the air, descending the mountain slopes, forms a warm dry föhn-like wind, termed the "bohorok," very injurious to the tobacco plantations. When this wind sets in in the morning, it sometimes drives before it a layer of cold air from the mountain slopes, and the onset of the "bohorok" is marked by a cold gust.

Observations at high levels are surprisingly frequent, especially when we consider that the plateau climate of Sumatra is bleak and chilly, in fact, quite untropical, with a thin drizzle in place of the usual tropical showers, but the data are none the less welcome. The enterprise of the Netherlands Meteorological Service is shown by the fact that autographic instruments were maintained on the summit of Mount Singgalang, 9,440 feet high, and some specimen thermograms and hygrograms are reproduced. The summit of the mountain is often shrouded in mist for days at a time, and some of the hygrograms are of great interest, showing how the depression of relative humidity at midday gets smaller and smaller day after day as the misty weather sets in, until the hygrogram shows merely a straight line at the level of saturation. We shall welcome the later parts of this second volume, dealing with other islands of the East Indies.

Books Received

Nautisk-Meteorologish Aarbog, 1925. The Danish Meteorological Institute, Copenhagen, 1926.

Deutsches Meteorologisches Jahrbuch for 1914 *to* 1918 *and* 1924. Sächsische Landeswetterwarte, Dresden, 1925 and 1926.

News in Brief

It was announced in the list of Honours awarded on the occasion of the King's Birthday that a knighthood had been conferred on Col. H. G. Lyons, F.R.S., Director and Secretary of the Science Museum and Acting-Director of the Meteorological Office, May, 1918, to April, 1919; and that Dr. G. C. Simpson, C.B.E., F.R.S., Director of the Meteorological Office, had been made a Companion of the Order of the Bath.

Staff News.—Mr. Michael Sugrue, assistant at Valencia Observatory, retired on June 30th. Mr. Sugrue joined the Observatory staff on June 18th, 1874, so that his service with the Meteorological Office reached the remarkable length of 52 years. During this period he has served with every superintendent who has held office at the Observatory since its foundation, and from all of them he received praise for the quality of his work and his devotion to duty. The whole staff join in wishing him many years of well merited rest.

Mr. F. H. West, Observer at Weymouth, sends us word that a small tornado, a few yards wide, was experienced there at 10h. 55m. (G.M.T.) on Thursday, June 24th. Two tents on the beach were lifted up and the woodwork smashed, and people had to cling to the wall. The barograph at the observing station, however, was not affected.

The Weather of June, 1926

Unlike June, 1925, which was so remarkably dry and sunny, the weather during the greater part of June, 1926, was of an unsettled character, with much rain during the first three weeks, occasional thunderstorms, and day temperature more often below normal than above it. On the 1st a secondary depression began to develop off southwest England causing heavy rain that night in Devon and Cornwall, a gale near the Channel Islands on the following day, and much rain generally in southern England ; 49 mm. (1·93 in.) were measured at Holne, Devon, on the 1st, and 37 mm. (1·45 in.) at Burgh Heath, Surrey, on the 2nd. The improvement in the rear of this depression lasted some days, and temperature rose well above 70° F. in many places on the 7th, 77° F. being reached at London (Camden Square). From the 8th to the 13th pressure was generally low over Ireland, while secondaries passed across England. Strong southwesterly winds were experienced on several parts of the coast, and attained gale force in northern Ireland and south Wales. Thunderstorms developed locally, and rainfall measurements exceeded 30 mm. at times in Ireland and northwest England, 76 mm. (3·00 in.) were measured at Delphi Lodge, Mayo, and 40 mm. (1·57 in.) at St. Michael's on Wyre, Lancs., on the 10th. Heavy rain fell again in northern England on the 14th and 15th, and in the southern part of the country about the 17th. At Norwich 13 mm. (0.52 in.) of rain and hail fell in about 5 minutes during a thunderstorm about noon on the 17th—many of the hailstones measured ½ to ¾ inch in diameter.

A marked improvement followed at the third week-end, temperature rising again above 70° at most places on the 19th, 20th and 21st (79° F. at Worksop, Nottingham and Kilkenny on the 20th). Subsequently high pressure extended from the Azores towards Iceland, giving cooler northerly winds for some days until near the end of the month, when the anticyclone moved east across the British Isles to the continent, causing a renewal of fine warm weather about the 27th. The total sunshine for the month was below normal in many parts, but the total rainfall varied considerably, being as much as 201 per cent. of the normal at Patching Farm, Sussex, and only 58 per cent. of the normal at Ledbury, Hereford.

Pressure was below normal in a belt extending over western

and central Europe, the Azores, Newfoundland and southwest Greenland, and above normal over Iceland, east Greenland, Spitsbergen, northern Scandinavia, most of Spain and in the Bermudas, the greatest excess being 6·9 mb. at Jan Mayen. Temperature was generally below normal and rainfall above normal over Europe, except that there was a deficit of rain in north Sweden and Spitsbergen. Snow fell heavily in Switzerland and the Chambéry and Cantal regions during the first days of the month, and torrential rains caused serious floods in the northern part of Bohemia and much damage at Pantchevo (Yugoslavia) and Odessa. On the 13th a violent thunderstorm swept over southwest Switzerland for a distance of about 15 miles and a width of 1 to 2 miles. Three woods were destroyed, and many people injured by falling roofs and trees. Another bad thunderstorm was reported from central Switzerland on the 22nd. Reports on the 18th and 21st showed that the Rhine, Moselle and Elbe were rising and overflowing their banks. About the middle of the month the Volga floods, which, since April, have devastated great tracts all along the river, began to subside. Floods have also occurred in the Caucasus, and the floods of the river Euphrates have not abated much, large areas near Samawah being still under water. On the other hand drought prevails in the Kliva and Bokhara Oases. The irrigating canals are dry as the river Oxus is changing its course, and the crops are therefore suffering.

Early in the month a heat wave occurred in Egypt, a temperature of 115° F. being reported from Cairo on the 9th.

As a result of snowstorms in the Andes, railway traffic between Argentina and Chile was interrupted about the 13th. Owing to the bursting of the Coecillo Dam flood water from the San Luisite River swept through the valley, destroying half the town of Leon (Mexico) on the 23rd.

Violent earthquakes and many minor shocks occurred in many parts of the world during the month.

The special message from Brazil states that the rainfall over the whole country was rather scarce, being 43 mm., 26 mm. and 30 mm. below normal in the northern, central and southern districts respectively. The anticyclones followed the normal tracks for this month, while depressions were very active. The coffee, cane, tobacco, cocoa and vegetable crops in the centre and south were generally in good condition. At Rio de Janeiro pressure was 0·6 mb. below normal, and temperature 1·1° F. above normal.

Rainfall, June, 1926—General Distribution

England and Wales ..	125	per cent. of the average 1881-1915.
Scotland	122	
Ireland	114	
British Isles	122	

Rainfall: June, 1926: England and Wales

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square	3·27	83	162	*War.*	Birminghm, Edgbaston	1·39	35	60
Sur.	Reigate, Hartswood	3·51	89	180	*Leics*	Thornton Reservoir	1·93	49	89
Kent.	Tenterden, Ashenden	2·20	56	115	,,	Belvoir Castle	2·21	56	116
,,	Folkestone, Boro. San.	2·84	72	...	*Rut.*	Ridlington	2·14	54	...
,,	Margate, Cliftonville	2·97	75	170	*Linc.*	Boston, Skirbeck	3·36	85	185
,,	Sevenoaks, Speldhurst	3·11	79	...	,,	Lincoln, Sessions House	2·70	69	133
Sus.	Patching Farm	4·06	103	201	,,	Skegness, Marine Gdns.	2·67	68	148
,,	Brighton, Old Steyne	3·15	80	175	,,	Louth, Westgate	3·55	90	164
,,	Tottingworth Park	3·93	100	187	,,	Brigg	3·77	96	180
Hants	Ventnor, Roy. Nat. Hos.	3·16	80	173	*Notts.*	Worksop, Hodsock	2·50	63	126
,,	Fordingbridge, Oaklnds	2·91	74	157	*Derby*	Mickleover, Clyde Ho.	3·11	79	130
,,	Ovington Rectory	2·34	59	101	,,	Buxton, Devon. Hos.	3·52	89	109
,,	Sherborne St. John Rec.	...	..	...	*Ches.*	Runcorn, Weston Pt.	1·73	44	67
Berks	Wellington College	2·63	67	121	,,	Nantwich, Dorfold Hall	1·70	43	...
,,	Newbury, Greenham	2·62	67	121	*Lancs*	Manchester, Whit. Pk.	2·04	52	77
Herts.	Benington House	3·66	93	178	,,	Stonyhurst College	2·25	57	73
Bucks	High Wycombe	2·84	72	146	,,	Southport, Hesketh	1·77	45	82
Oxf.	Oxford, Mag. College	2·49	63	117	,,	Lancaster, Strathspey	3·10	79	...
Nor.	Pitsford, Sedgebrook	1·79	45	93	*Yorks*	Sedbergh, Akay	3·39	86	102
,,	Eye, Northolm	...	..	...	,,	Wath-upon-Dearne	3·26	83	147
Beds.	Woburn, Crawley Mill	2·47	63	126	,,	Bradford, Lister Pk.	2·98	76	127
Cam.	Cambridge, Bot. Gdns.	...	..	...	,,	Wetherby, Ribston H.	3·61	92	172
Essex	Chelmsford, County Lab	2·84	72	149	,,	Hull, Pearson Park	4·02	102	195
,,	Lexden, Hill House	3·29	84	...	,,	Holme-on-Spalding	6·47	164	...
Suff.	Hawkedon Rectory	2·76	70	133	,,	West Witton, Ivy Ho.	2·40	61	...
,,	Haughley House	2·58	66	...	,,	Felixkirk, Mt. St. John	4·60	117	210
Norf.	Beccles, Geldeston	3·15	80	175	,,	Pickering, Hungate	3·42	87	...
,,	Norwich, Eaton	2·71	69	140	,,	Scarborough	3·26	83	177
,,	Blakeney	2·31	59	124	,,	Middlesbrough	2·45	62	130
,,	Swaffham	2·56	65	120	,,	Baldersdale, Hury Res.	2·82	72	120
Wilts.	Devizes, Highclere	3·23	82	143	*Durh.*	Ushaw College	3·52	89	163
,,	Bishops Cannings	2·52	64	104	*Nor.*	Newcastle, Town Moor.	3·52	89	162
Dor.	Evershot, Melbury Ho.	2·50	64	110	,,	Bellingham, Highgreen	3·92	100	...
,,	Creech Grange	3·41	87	...	,,	Lilburn Tower Gdns.	5·73	146	...
,,	Shaftesbury, Abbey Ho.	2·54	64	110	*Cumb*	Geltsdale	4·43	113	...
Devon	Plymouth, The Hoe	3·39	86	157	,,	Carlisle, Scaleby Hall	3·50	89	139
,,	Polapit Tamar	2·80	71	130	,,	Seathwaite M.	9·15	232	140
,,	Ashburton, Druid Ho.	4·85	123	190	*Glam.*	Cardiff, Ely P. Stn.	1·80	46	72
,,	Cullompton	3·04	77	143	,,	Treherbert, Tynywaun	3·54	90	...
,,	Sidmouth, Sidmount	3·43	87	163	*Carm*	Carmarthen Friary	1·91	49	67
,,	Filleigh, Castle Hill	2·34	59	...	,,	Llanwrda, Dolaucothy	3·14	80	92
,,	Barnstaple, N. Dev. Ath.	2·19	56	98	*Pemb*	Haverfordwest, School	2·44	62	90
Corn.	Redruth, Trewirgie	3·30	84	133	*Card.*	Gogerddan	2·54	65	82
,,	Penzance, Morrab Gdn.	2·73	69	123	,,	Cardigan, County Sch.	2·16	55	...
,,	St. Austell, Trevarna	3·57	91	137	*Brec.*	Crickhowell, Talymaes	2·80	71	...
Soms	Chewton Mendip	3·38	86	114	*Rad.*	Birm. W. W. Tyrmynydd	2·81	71	86
,,	Street, Hind Hayes	3·22	82	...	*Mont.*	Lake Vyrnwy	2·43	62	77
Glos.	Clifton College	1·63	41	66	*Denb.*	Llangynhafal	1·64	42	...
,,	Cirencester, Gwynfa	2·08	53	84	*Mer.*	Dolgelly, Bryntirion	4·53	115	130
Here.	Ross, Birchlea	1·42	36	65	*Carn.*	Llandudno	1·47	37	72
,,	Ledbury, Underdown	1·31	33	58	,,	Snowdon, L. Llydaw 9	...	..	...
Salop	Church Stretton	2·34	59	97	*Ang.*	Holyhead, Salt Island	1·38	35	64
,,	Shifnal, Hatton Grange	1·52	39	68	,,	Lligwy	2·21	56	...
Staff.	Tean, The Heath Ho.	2·01	51	78	*Isle of Man*				
Worc.	Ombersley, Holt Lock	1·42	36	63		Douglas, Boro' Cem.	2·20	56	91
,,	Blockley, Upton Wold	2·48	63	93	*Guernsey*				
War.	Farnborough	2·77	70	116		St. Peter P't, Grange Rd	3·98	101	215

Rainfall: June, 1926: Scotland and Ireland

CO.	STATION	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	1·59	40	65	*Suth.*	Loch More, Achfary	3·65	93	99
,,	Pt. William, Monreith	2·24	57	...	*Caith*	Wick	1·54	39	86
Kirk.	Carsphairn, Shiel.	4·31	109	...	*Ork.*	Pomona, Deerness	2·21	56	120
,,	Dumfries, Cargen	4·47	114	161	*Shet.*	Lerwick	1·41	36	79
Roxb	Branxholme	3·45	88	153					
Selk.	Ettrick Manse	5·45	139	...	*Cork.*	Caheragh Rectory	5·07	129	...
Berk.	Marchmont House	3·83	97	166	,,	Dunmanway Rectory.	4·23	107	121
Hadd	North Berwick Res.	2·86	73	172	,,	Ballinacurra	2·73	69	105
Midl	Edinburgh, Roy. Obs.	2·95	75	160	,,	Glanmire, Lota Lo.	3·67	93	136
Lan.	Biggar	3·03	77	147	*Kerry*	Valencia Obsy.	...	..	...
,,	Leadhills	5·53	140	...	,,	Gearahameen	3·30	84	...
Ayr.	Kilmarnock, Agric. C.	1·76	45	80	,,	Killarney Asylum	3·92	100	135
,,	Girvan, Pinmore	2·21	56	76	,,	Darrynane Abbey	4·15	105	132
Renf.	Glasgow, Queen's Pk.	2·02	51	87	*Wat.*	Waterford, Brook Lo.	2·09	53	78
,,	Greenock, Prospect H.	3·62	92	110	*Tip.*	Nenagh, Cas. Lough	2·75	70	112
Bute.	Rothesay, Ardencraig.	3·09	78	101	,,	Tipperary	2·73	69	...
,,	Dougarie Lodge	2·72	69	...	,,	Cashel, Ballinamona	2·45	62	107
Arg.	Ardgour House	3·79	96	...	*Lim.*	Foynes, Coolnanes	3·93	100	152
,,	Manse of Glenorchy	4·74	120	...	,,	Castleconnell Rec.	3·53	90	...
,,	Oban	3·08	78	...	*Clare*	Inagh, Mount Callan	...	..	...
,,	Poltalloch	3·07	78	101	,,	Broadford, Hurdlest'n.	3·57	91	...
,,	Inveraray Castle	4·25	108	107	*Wexf*	Newtownbarry	...	..	...
,,	Islay, Eallabus	3·30	84	126	,,	Gorey, Courtown Ho.	...	..	...
,,	Mull, Benmore	7·90	201	...	*Kilk.*	Kilkenny Castle	2·17	55	89
Kinr.	Loch Leven Sluice	3·50	89	160	*Wic.*	Rathnew, Clonmannon	1·72	44	...
Perth	Loch Dhu	4·95	126	119	*Carl.*	Hacketstown Rectory	2·89	73	103
,,	Balquhidder, Stronvar.	4·52	115	118	*QCo.*	Blandsfort House	...	..	...
,,	Crieff, Strathearn Hyd.	2·62	67	99	,,	Mountmellick	3·07	78	...
,,	Blair Castle Gardens	2·45	62	124	*KCo.*	Birr Castle	2·61	66	113
,,	Coupar Angus School	2·60	66	139	*Dubl.*	Dublin, FitzWm. Sq.	2·34	59	120
Forf.	Dundee, E. Necropolis	3·05	77	169	,,	Balbriggan, Ardgillan	2·30	58	114
,,	Pearsie House	4·01	102	...	*Me'th*	Drogheda, Mornington	...	..	...
,,	Montrose, Sunnyside	2·34	59	141	,,	Kells, Headfort	2·70	69	102
Aber.	Braemar, Bank	3·41	87	174	*W.M*	Mullingar, Belvedere	3·43	87	132
,,	Logie Coldstone Sch.	3·52	89	180	*Long*	Castle Forbes Gdns.	3·54	90	137
,,	Aberdeen, King's Coll.	1·60	41	94	*Gal.*	Ballynahinch Castle	5·90	150	167
,,	Fyvie Castle	2·84	72	...	,,	Galway, Grammar Sch.	4·58	116	...
Mor.	Gordon Castle	2·78	71	136	*Mayo*	Mallaranny	4·69	119	...
,,	Grantown-on-Spey	2·44	62	108	,,	Westport House	4·11	104	152
Na.	Nairn, Delnies	2·22	57	126	,,	Delphi Lodge	8·30	211	...
Inv.	Ben Alder Lodge	3·33	85	...	*Sligo*	Markree Obsy.	3·55	90	118
,,	Kingussie, The Birches	1·91	49	...	*Cav'n*	Belturbet, Cloverhill	3·09	78	127
,,	Loch Quoich, Loan	6·00	152	...	*Ferm*	Enniskillen, Portora	2·98	76	...
,,	Glenquoich	...	..	...	*Arm.*	Armagh Obsy.	2·64	67	105
,,	Inverness, Culduthel R.	1·88	48	...	*Down*	Warrenpoint	2·38	60	...
,,	Arisaig, Faire-na-Squir	...	..	...	,,	Seaforde	2·89	73	105
,,	Fort William	3·29	84	92	,,	Donaghadee, C. Stn.	1·64	42	70
,,	Skye, Dunvegan	1·91	49	...	,,	Banbridge, Milltown	1·96	50	77
,,	Barra, Castlebay	1·20	31	...	*Antr.*	Belfast, Cavehill Rd.	2·34	59	...
R&C	Alness, Ardross Cas.	3·16	80	140	,,	Glenarm Castle	2·29	58	...
,,	Ullapool	2·26	57	...	,,	Ballymena, Harryville	2·50	64	86
,,	Torridon, Bendamph	3·35	85	82	*Lon.*	Londonderry, Creggan	3·42	87	121
,,	Achnashellach	4·58	116	...	*Tyr.*	Donaghmore	2·68	68	...
,,	Stornoway	2·05	52	88	,,	Omagh, Edenfel	2·83	72	100
Suth.	Lairg	2·66	68	...	*Don.*	Malin Head	2·34	59	109
,,	Tongue Manse	3·36	85	164	,,	Dunfanaghy	...	..	...
,,	Melvich School	1·81	46	93	,,	Killybegs, Rockmount	3·42	87	90

Climatological Table for the British Empire, January, 1926

STATIONS	PRESSURE		TEMPERATURE								PRECIPITATION				BRIGHT SUNSHINE		
			Absolute		Mean Values				Mean								
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb.	Relative Humidity	Mean Cloud Am'nt	Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1012·1	− 5·5	53	18	45·5	35·7	40·6	+ 1·7	38·4	90	7·9	59	+ 14	18	1·4	16
Gibraltar	1022·0	+ 0·8	67	45	62·4	51·8	57·1	+ 2·3	51·8	84	5·5	109	− 20	8	...	...
Malta	1017·0	− 0·6	67	46	59·4	52·2	55·8	+ 0·5	52·0	81	6·5	68	− 14	13	5·3	54
St. Helena	1013·1	+ 3·4	72	58	67·1	59·9	63·5	− 1·0	61·3	88	4·3	56	− 19	21	...	...
Sierra Leone	1012·5	+ 1·3	90	70	86·8	73·2	80·0	− 1·5	72·1	77	3·4	0	− 10	0	...	...
Lagos, Nigeria	1008·9	− 1·0	92	68	89·7	75·0	82·3	+ 1·4	73·7	77	6·7	0	− 27	0	...	...
Kaduna, Nigeria	1014·9	+ 3·3	94	...	86·8	...	...	...	?54·9	? 19	4·0	0	0	0	...	...
Zomba, Nyasaland	1012·8	− 0·9	87	64	81·1	66·3	73·7	+ 0·9	...	88	9·5	711	+445	28	...	...
Salisbury, Rhodesia	1006·7	− 1·9	85	53	79·0	61·3	70·1	+ 0·6	63·8	77	6·8	143	− 58	19	6·2	47
Cape Town	1014·3	+ 1·1	94	50	81·7	60·6	71·1	+ 1·3	63·9	71	2·7	8	− 10	4	...	...
Johannesburg	1010·3	+ 0·7	88	50	80·6	57·7	69·1	+ 2·9	60·0	67	3·1	192	+ 33	16	8·8	65
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	101	51	93·2	61·9	77·5	+ 4·3	66·7	59	3·0	76	− 26	3	...	...
Calcutta, Alipore Obsy.	1016·4	+ 1·2	82	49	77·1	55·3	66·2	− 0·2	56·3	86	2·2	14	+ 5	3*	...	...
Bombay	1013·6	0·0	89	63	83·6	69·7	76·7	+ 1·4	66·2	73	2·0	76	+ 73	4*	...	...
Madras	1014·6	+ 0·5	86	63	84·2	69·7	76·9	+ 0·8	72·8	88	4·3	28	− 7	3*	...	...
Colombo, Ceylon	1011·6	+ 0·1	92	66	87·7	71·1	79·4	+ 0·3	73·9	73	4·6	64	− 25	9	4·6	39
Hong Kong	1021·6	+ 1·8	76	52	66·0	57·6	61·8	+ 1·6	56·2	72	5·5	5	− 30	2	5·6	51
Sandakan	...	...	86	72	83·2	75·0	79·1	− 0·7	75·7	82	...	753	+284	17	...	...
Sydney	1010·7	− 1·8	104	58	79·2	64·6	71·9	+ 0·3	66·1	63	6·1	90	− 3	13	7·6	54
Melbourne	1013·4	+ 0·5	104	51	73·8	55·5	64·7	− 2·8	57·4	60	5·5	89	+ 42	11	7·5	52
Adelaide	1014·5	+ 1·5	102	51	83·6	58·0	70·8	− 3·3	58·3	36	3·2	1	− 17	1	11·2	79
Perth, W. Australia	1012·8	+ 0·3	106	56	88·9	65·8	77·3	+ 3·4	63·9	41	3·0	1	− 7	2	10·8	78
Coolgardie	1011·9	+ 0·5	103	54	94·2	64·3	79·3	+ 1·9	61·9	39	1·3	0	− 12	0	...	...
Brisbane	1010·9	− 0·5	97	65	86·4	69·3	77·9	+ 0·7	70·8	66	5·6	77	− 86	12	7·5	55
Hobart, Tasmania	1010·5	+ 0·2	82	43	68·3	51·3	59·8	− 2·5	53·7	59	6·5	38	− 7	9	8·2	55
Wellington, N.Z.	1011·5	− 1·3	81	46	70·7	57·3	64·0	+ 1·6	58·2	69	6·8	78	− 6	13	7·4	50
Suva, Fiji	1007·9	+ 0·2	89	69	86·1	74·5	80·3	+ 0·4	75·9	81	5·1	129	−143	15	7·3	56
Apia, Samoa	1007·7	− 0·2	91	71	85·8	76·2	81·0	+ 2·0	77·7	77	6·3	278	−149	19	6·3	49
Kingston, Jamaica	1014·9	− 0·2	91	64	85·9	69·1	77·5	+ 0·7	66·2	80	2·8	11	− 13	3	3·1	28
Grenada, W.I.	1014·9	+ 2·3	84	70	82·3	72·1	77·2	+ 0·2	72·6	78	4·6	88	− 25	22	...	...
Toronto	1014·8	− 2·6	46	− 5	30·8	18·7	24·7	+ 2·6	22·4	80	8·1	58	− 15	18	1·8	19
Winnipeg	1016·2	− 3·6	34	−29	14·5	−2·5	6·0	+10·4	...	...	5·7	10	− 11	8	3·1	36
St. John, N.B.	1011·0	− 4·7	44	−13	25·8	10·7	18·3	− 0·9	15·9	77	6·0	155	+ 33	16	3·0	33
Victoria, B.C.	1020·4	+ 5·1	52	34	45·2	39·4	42·3	+ 2·2	39·9	93	9·1	89	− 26	15	1·3	15

*For Indian stations a rain day is a day on which [illegible] in. ([illegible] mm.) or more rain has fallen.

Victoria, B.C.	1020·4	+ 5·1	52	34	[illegible]	[illegible]	[illegible]	− 0·9	15·9	77	6·0	155	+ 33	16	3·0	33
					45·2	39·4	42·3	+ 2·2	39·9	93	9·1	89	− 26	15	1·3	15

*For Indian stations a rain day is a day on which ... or more rain has fallen.